In Motion:
Part 1 Exploring Parkinson's Driving Concerns

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Objectives

1. Associate features of Parkinson's disease with the impact of PD on driving, focusing on risk factors
2. Explain how autonomous vehicle technology can mitigate driving errors and potentially enhance fitness-to-drive in real-world driving.
3. Review intervention strategies.

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How PD Symptoms and Medications Affect Driving

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Motor Features Of PD That Might Affect Driving

Bradykinesia[1]	• Slowness of movement • Freezing of gait, festinating or shuffling
Rigidity[3]	• "Cogwheel" (fluctuating) or "lead pipe" (continuous) • Can affect extremities or neck
Postural instability[4]	• Balance issues • Kyphosis

PD, Parkinson's disease. **1.** Parkinson's Organization…Bradykinesia-Slowness-of-Movement (2023) **3.** Ferreira-Sánchez et al. (2020). **4.** Palakurthi & Burugupally (2019).

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Nonmotor Features of PD

Psychiatric disorders[1, 2]	• Depression • Anxiety • Hallucination – **visual**, auditory, olfactory or tactile • Delusions
Cognitive disorders[1, 3-5]	• Mild cognitive impairment • Dementia • Impulsivity
Sleep abnormalities[1,3]	• REM sleep behavior disorder • Sleep attacks

PD, Parkinson's disease; REM, rapid eye movement.
1. Khedr et al. (2020). 2. Diederich (2009) 3. Armstrong & Okun, 2020 4. Frundt et al.(2022) 5. Aarsland (2016).

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Nonmotor Features of PD

Autonomic dysfunction[1]	• Orthostatic hypotension
Miscellaneous[2,3]	• Fatigue Pain Syndrome

PD, Parkinson's disease; REM, rapid eye movement. 1. Schapira, Chaudhuri and Jenner. 2 Armstrong and Okun… 3. Tai and Lin (2020)

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PD Meds and Driving

- On/off state[1]
- Monoamine oxidase B (MAO B) inhibitors – may increase the risk of hallucinations[2]
- Dopamine agonists - Can cause Sleep Attacks[3, 4]
  - Pramipexole – Mirapex
  - Ropinirole - Requip
  - Rotigotin - Neupro

1. Uc et al. (2009) 2. Mayo Foundation for Medical Education and Research (2023) 3. Ueno et al. (2017) 4. Meindorfner et al. (2005)

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Discuss with Your Neurologist

- Do you ever suddenly fall asleep?
- Do you hallucinate? What type of hallucination?
- Do you have delusions?
- Has there been an increase in impulsivity?
- Do you ever get dizzy while seated?
- Does your family or friends feel safe driving with you?

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Study Findings

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Drivers with PD Impaired Driving Ability

- Make **more driving errors** compared to controls in simulator [1 2]
- PD patients had a significantly greater number of driving simulator collisions [3]
- **Fail an on-road test** more compared to controls [4]
  - The most important driving performance predictors of failure in the road test were
    - Difficulties in turning left at intersections
    - Lane maintenance at low speed
    - Speed adaptations at high speed[5]

1. (Devos et al., 2007 2. Stolwyk et al., 2006 3. Zesiewicz et al., 2002 4. Ranchet et al. (2019) 5. Devos et al. (2013)

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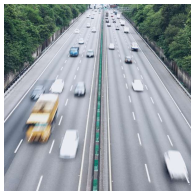
Critical Errors

- Drivers with PD made significantly more errors than the control group[1]:
  - Changing lanes
  - Lane keeping,
  - Monitoring their blind spot,
  - Reversing
  - Parking
  - Traffic light-controlled intersections



1. Wood et al. (2005)

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Drivers with PD impaired driving ability

- Self- regulation[1,2]
  - More restrictive driving patterns than age and gender matched controls
  - Drove significantly less overall
  - Drove closer to home
  - Drove less at night
  - Drove less on days with bad weather
  - Adjusted their travel route by avoiding high speed roads

1. Ranchet et al. (2019) 2. Crizzle et al. (2013)

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Driving Performance of People with Parkinson's using Autonomous Vehicle Technologies

Rationale

Our work and that of others have shown that drivers with **PD make more driving errors, in the simulator** when compared to healthy controls.

Drivers with **PD make significantly more errors** in speeding, lane exceedances and signaling which are predictive of poorer performance in a driving simulator and failing an on-road evaluation

Hypothesis

Drivers with PD will demonstrate fewer total number of driving errors (primary outcome) and fewer speeding, lane exceedances, and signaling errors, when driving with vs. without autonomous in-vehicle technology in an on-road vehicle in real-world traffic.

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ADAS and IVIS

Advanced Driver Assistance Systems – (ADAS) – Includes technologies that assist drivers with the safe operation of a vehicle. It may assist with steering or speed control.

In Vehicle Information Systems (IVIS) – Technologies that provide information or warnings to drivers but do not assume functions related to driving tasks.

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GARMIN 03/27/2023 03:03:04 PM 29.60943 -82.36302 46 MPH

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SIDE
MIRRORS

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Preliminary results

Results On-road
More errors in suburban than highway (under both conditions)
Strongest benefit of ADAS was to correct under speeding on highway section*
Impact of alert-based IVIS for lane departure warning was less than anticipated

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Clinical implications

IVIS and ADAS features can assist drivers with PD

- IVIS and ADAS were shown to reduce the total number of errors made by driver with PD over the totality of the drive (Highway and Suburban sections combined).
- ACC can help with under speeding, a predominant error shown in this study and prior work.
- Lane warning features (IVIS) and lane keeping assist support lane maintenance, another area where drivers with PD are more prone to errors.

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Intervention Strategies

- When considering IVIS or ADAS technologies, understanding the circumstances under which those features work best and what the limitations are will help match recommendations the driver's needs.
  - Does it only work on certain types of roads?
  - Does it only work at certain speeds?
  - Under what conditions might it stop working (weather or infrastructure related)? For example, lane keeping assist will not work when lane lines are faint or covered with snow or dirt.
  - Does it have to activated each time the person drives?

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Consensus Guides / Drivers with PD

- Driving may be maintained – especially early in the diagnosis.
- Work closely with neurologist re: treatment
- Annual evaluation recommended
- Consider use of vehicle technologies that can assist
- Early consideration of plan for community mobility after driving

Classen, S. (2014)

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QUESTIONS

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Advisory Board

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